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THE LOCALITIES AND HORIZONS OF PERMIAN VERTEBRATE FOSSILS IN TEXAS

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The vertebrate fossils from the Permian formation in Texas described by Professor E. D. Cope were collected by myself and others before any stratigraphic work had been done in the part of the state in which that formation occurs, and the only thing that could be done by the collector was to give the locality from which the specimen was taken. Whether the different localities were of the same horizon or whether they were entirely different beds was not known, and consequently could not be given.

At a subsequent period, as a member of the Texas Geological Survey, I made a thorough examination of the country and complete stratigraphic sections across the entire Permian area. These sections were published in the *Second Annual Report* of the Survey.

After the stratigraphic work had been done, I took up, with Professor Cope, the work of giving the horizon of each of his described forms and the study of the development of the forms of life. Unfortunately, before the completion of this work the death of Professor Cope occurred, and his collection passed into other hands and the paper was not prepared. Later, I asked Professor Osborne, into whose hands most of Professor Cope's Permian fossils had gone, to send me the localities as given on the labels with the fossils collected from Texas. The request was referred to Professor E. C. Case, who very kindly furnished me with such facts as the labels disclosed.

More recently, Dr. W. D. Matthews, of the American Museum of Natural History, New York, sent me the card list and the original lists sent to Professor Cope by the collectors, together with the original correspondence relating to the collections.

From these sources I have been enabled to give the localities of most of the vertebrate fossils collected.

After these fossils had been collected, Dr. C. A. White, of the United States Geological Survey, came to Texas, and together we

visited the Permian beds and made a collection of the invertebrate fossils. Part of these occurred at some of the same localities as those from which Cope's vertebrate forms were taken. These invertebrates were afterward described by Dr. White (*Amer. Nat.*, 1889, p. 128, and United States Geological Survey, *Bull. No. 77*).

Subsequently further collections of invertebrate fossils were made by myself and other members of the Texas Survey. The cephalopods were placed in the hands of Professor Alpheus Hyatt for determination and description. His reports were published as parts of the *Second* and *Fourth Annual Reports* of the Texas Geological Survey.

The fossil flora was sent to Professors Fontaine and I. C. White for their determination. A paper was published by them (*Bulletin of the Geological Society of America*, Vol. III, pp. 217, 218), giving the results of their study.

It is the purpose of this paper to describe more accurately the various localities from which the fossils were taken, to indicate their stratigraphic relation to the general section, and bring together a list of the vertebrate forms¹ so far described from each locality, as nearly as it is possible to give it from existing data.

THE GENERAL SECTION

The Permian deposits were described and separated into divisions in the several reports of the Geological Survey of Texas. As a whole, the formation comprises a series of sands and clays with interbedded sandstones, limestones, and gypsum, lying conformably and with a gentle westward dip upon the Coal Measures to the east and stretching to the foot of the Staked Plains on the west. Three divisions are recognized, the earliest and most easterly being the Wichita, followed successively by the Clear Fork and Double Mountain.

The Wichita division comprises a series of sandstones, sandy shales, clays, and conglomerate, which passes gradually to the southward into sandstones, clays, and limestone. In the earlier reports, there being no apparent stratigraphic break between it and the underlying Coal Measures and its materials being quite different from the Wichita, these beds in the southern part of this field were

¹ The lists sent me include batrachia and reptilia only. The fish will, therefore, not be included in this.

called the Albany beds and were assigned to the Coal Measures. Subsequent study, however (*Texas Academy of Science Trans.*, Vol. II, pp. 93-98), disclosed the fact that the beds were stratigraphically continuous with the Wichita, being simply deposits in deeper waters, and in all subsequent publications they have been included in the Wichita, referred to the Permian, and the name Albany dropped.

The Clear Fork beds are composed of bedded limestone, magnesian and earthy, followed by clays, limestones, and shales, and are more sandy toward the top.

The Double Mountain beds comprise sandstones, sandy shales, earthy limestone, clays, and thick beds of gypsum.

For details of the sections reference is made to the *Second Annual Report* of the Geological Survey of Texas, pp. 402 ff.

So far as our collections show, the first vertebrate fossils are found in beds which are a little below the middle of the Wichita division. The beds below these, while not differing materially in character, are possibly the representatives of the transition beds of the territory north, as Adams suggests,¹ but from the evidence here given it is plain that such a reference cannot apply to any beds west of Onion Creek.

In describing these localities I have begun with those nearest the base and have given them as nearly in stratigraphic sequence as our present knowledge will permit.

I have tried to give all localities at which we made collections of vertebrate fossils, whether the forms have been identified or not.

LOCALITIES OF WICHITA DIVISION

Onion Creek.—A few miles east of Archer City there is a small tributary on the south side of the Little Wichita River called Onion Creek. Near the mouth of this stream, the first fossil vertebrate of the Texas Permian was found by Professor Jacob Boll, who afterwards sent it to Professor Cope.

Cottonwood Creek.—This creek is about ten miles south of Archer City and is a tributary of the South Fork of Little Wichita.

Fire Place.—This is on the west side of the South Fork of the Little Wichita about six miles south of Archer City. It is one of Boll's localities.

¹ *Bulletin of the Geological Society of America*, Vol. XIV, pp. 191-200.

Elm Creek.—A tributary of the South Fork of the Little Wichita, about twelve miles southwest of Archer City. Collections were made on east side of creek.

Fossils: *Dimetrodon gigas*, *D. dollovianus*

Post Oak Pens.—This locality is south of the head of Kickapoo Creek, on the head of the South Fork of the Little Wichita River about fifteen miles southwest of Archer City. From here I took quite a collection of the teeth of fishes. The horizon is below that of Tit Mountain, or Corn Hill.

Copper Mines.—About one-half mile east of the copper mines there is a small area of "bad lands" at which place I collected some fragments of vertebrates and many teeth. This is about the same horizon as Post Oak Pens. This locality is four miles west of Archer City.

Long Creek.—This creek runs into the Little Wichita on the north side, just a little west of the copper mines.

Fossils: *Empedias alatus*, *Dimetrodon incisivus*, *Naosaurus cruciger*

Mount Barry.—This is a prominent hill in the valley of the Big Wichita about ten miles west of Wichita Falls. This is about the middle of the Wichita division.

Fossils: *Empedias alatus*

Briar Creek.—A small branch running into the North Fork from the south side, a few miles west of Kickapoo Creek.

Fossils: *Naosaurus cruciger*

Slippery Creek.—This is a small creek that runs into the North Fork of the Little Wichita from the north side almost directly south of the town of Dundee, and a little above the mouth of Briar Creek on the south side.

Fossils: *Trimerorhachis sp.*, *Eryops sp.*, *Dimetrodon incisivus*, *D. giganhomogenes*, *Ctenosaurus sp.*

Cox's Camp.—A few miles east of the mouth of Godwin Creek, when the collections for Cope were being made, the Harrold Brothers had a line riders' camp, known as Cox's camp. Just east of that camp, on the north side of the Little Wichita River, there is a small area of "bad lands." At this place one of the best-preserved fossils in the entire Cope collection was found.

Fossils: *Trimerorhachis* sp., *Eryops* sp., *Empedias* sp.

Headquarters.—The first headquarters established by Harrold Brothers for their extensive ranch was on the north side of the North Fork of the Little Wichita River, a mile or two from the mouth of Kickapoo Creek, a tributary of the North Fork from the south side. Some of Cope's fossils were taken from this locality.

Corn Hill.—Corn Hill, formerly called Tit Mountain, is No. 31 of our section and is about a mile north of Dundee, and is higher in the formation than the beds at Mount Barry.

Fossils: *Trimerorhachis bilobatus*, *T. sp.*, *Dimetrodon incisivus*, *D. macrospondylus*, *D. longiramus*

Godwin's Creek.—A tributary of the Little Wichita River from the south side. It runs from a southwestward direction nearly on the strike of the beds, having its source in the limestone hills of the Clear Fork Division ten miles away. From its mouth to the crossing of the road from Archer City to Seymour there is quite a body of "bad lands." Several specimens of Cope's fossils were taken from this place. About one-half mile east of the crossing of the Archer and Seymour road is Dr. C. A. White's Godwin Creek invertebrate locality. About two miles up the creek, on the south side above the road crossing, is the locality from which the fossil flora was taken described by Dr. I. C. White as coming from Godwin's Creek. The Antelope locality in the same paper is Carboniferous.

Fossils: *Diadectis* sp., *Empedias fissus*, *Dimetrodon platycentrus*

Hackberry Creek.—This is a small tributary of the Little Wichita river, about three miles southeast of Fulda. It is one of Mr. Sternberg's localities.

Fossils: *Eryops* sp., *Diadectes* sp.

Deep Red Run.—There was at one time a small fort called Fort Auger on the north side of Red River about opposite where the town of Iowa Park is now located. There was a road leading from Fort Auger to Fort Sill. Near the crossing of Deep Red Creek by this old road is the locality at which I collected the vertebrates in Cope's collection labelled "Indian Territory." The horizon is about the same as that of Corn Hill.

Fossils: *Cricotus hypantricus*, *Dimetrodon gigas*, *D. macrospondylus*, *D. dollovi*, *D. platycentrus*, *Naosaurus cruciger*

Camp Creek.—About four miles west of Tit Mountain. It was named from the fact that Harrold Brothers had one of their line camps on it. At this place appears the first limestone as we go up the south side of the Big Wichita River. It is one of Dr. C. A. White's invertebrate localities.

Big Wichita.—Going west from Camp Creek and before reaching the locality designated as Military Crossing, there is an exposure of the beds given as No. 29 in the Section on p. 403, *Second Annual Report* Texas Geological Survey. This is not "Big Wichita" of Boll's collections. He used the term for various localities along the river.

Fossils: *Eryops* sp., *Clepsydropus leptcephalus*, *Theropleura retroversa*

Moonshine.—A small creek that runs into the Big Wichita River near the east line of Baylor County has the name of Moonshine. At this place I found a few vertebrate fossils.

Fossils: *Chilonyx rapidens*, *Dimetrodon gigas*

Military Crossing.—Before there were any other roads through this country or crossings on the Big Wichita River, Maj. Van Dorn made a road from Fort Belknap to old Fort Radminski, at the western end of the Wichita Mountains near Otter Creek. This road crossed the north fork of the Little Wichita River near its head. It crossed the Big Wichita River at the eastern foot of the hills a little west of north of Fulda and near where, at a later date, the west line of the "99" pasture fence was built. This crossing has been abandoned for a great number of years and the locality must not be confused with the old cattle trail made several years later, nor the county road made between the two crossings at a still later date. About one and a half miles north of this crossing, on the Big Wichita River, is a small dry creek. On the north side of that creek, about one-fourth of a mile from the old road, is the locality known as Military Crossing. This horizon is near the top of the Wichita Division. This locality furnished the greater number of the invertebrates collected by Dr. White.

In addition to the forms given under the above localities, the following were collected within the area occupied by the Wichita division, but the localities are not given closely enough to permit their being referred to any definite horizon: *Zatrachys seratus*, *Eryops*

megacephalus, *Cricotus crassidiscus*, *Diadectes phaseolinus*, *D. latibuccatus*, *Empedias molaris*, *Pariotichus brachyops*, *Pantylus cordatus*, *Clepsydropus natalis*, *C. limbatus*, *Dimetrodon semiradicatus*, *Metamosaurus josssatus*, *Paleosaurus uniformis*, *Embolobus ritillus*

So far as known none of these species occur above the Wichita beds.

As has been stated, the continuations of these beds to the south comprise deposits of deeper water and carry a large invertebrate fauna. The details of the stratigraphy and fossils of this division on the Colorado river are given by Dr. Drake in the *Fourth Ann. Rep. Geol. Sur. Tex.*, pp. 421 ff.

Ballinger and North of Abilene, the localities of Professor Hyatt's cephalopods, are well known. They are the same horizon as that of Military Crossing.

LOCALITIES OF CLEAR FORK DIVISION

Coffee Creek.—In the northeastern corner of Baylor County, about four miles west of Military Crossing, a small stream, generally dry, runs into the Big Wichita River from the north. The old cattle trail crossed the Big Wichita River about three miles above the mouth of Coffee Creek. As will be seen, this was a very prolific locality for collectors:

Fossils: *Diplocaulus magnicornis*, *D. limbatus*, *D. sp.*, *Trimerorhachis mesops*, *Zatrachys microphthalmus*, *Eryops sp.*, *Acheloma cumminsi*, *Anisodexis imbrocarius*, *Diadectes phaseolinus*, *D. sp.*, *Pariotichus aguti*, *Captorhinus angusticeps*, *Pantylus tryptychus*, *P. coicodus*, *Labradoraus hamatus*, *L. sp.*, *Dimetrodon gigas*, *D. dollovianus*, *Naosaurus claviger*, *N. cruciger*, *N. macrodus*, *Edaphosaurus pagonias*

Boneyard.—The old cattle trail from the south to the north, at the time the Cope collections were made, crossed the Big Wichita River about two and a half miles above Coffee Creek. Just east of that road, on the north side of the river, is an area of "bad lands." At this place there were a great number of fragments of vertebrates, so much so that Mr. Sternberg gave it the name of "Boneyard" and so labelled many of the fossils collected by him.

Fossils: *Diadectes sp.*, *Empedias sp.*

Beaver Creek.—At the crossing on Beaver Creek of the old cattle trail mentioned elsewhere as crossing the Big Wichita River west of Coffee Creek is another locality at which I collected fossils for Cope. Boll's locality "Beaver Creek" was at its mouth and in the Wichita Beds.

Brushy Creek.—Six miles northwest of Seymour is the head of Brushy Creek, which runs into the Big Wichita River on the south side.

Fossils: *Eryops* sp., *Diadectes* sp.

Indian Creek.—This creek runs into the Big Wichita River on the north side nearly opposite the mouth of Brushy Creek.

Fossils: *Diplocaulus* sp., *Trimerorhachis conangulus*, *Eryops* sp., *Diadectes* sp., *Pariotichus isolomus*, *Isodectes megalops*, *Dimetrodon giganhomogenes*, *Naosaurus claviger*

Gray Creek.—In same vicinity, south of river.

Fossils: *Otocoelus testudineus*, *Conodectes javosus*

Crooked Creek and Hog Creek.—Same vicinity, south of river.

Fossils: *Diplocaulus* sp., *Labidosaurus* sp., *Naosaurus claviger*

Stamford.—While connected with the Texas Geological Survey, I collected some vertebrates from the Clear Fork beds in Haskell County, Texas, near Otey's Creek, not far from the present town of Stamford (*Second Ann. Rept. Tex. Geol. Surv.*, p. 405.)

Other forms described from the Clear Fork division but not localized are: *Zatrachys conchigerus*, *Dissorhopus multicinctus*, *Bolbodon tenuitectus*, *Pariotichus isolomus*, *Hypopnous squaliceps*, *Otocoelus mimeticus*

The forms described from this region which we cannot certainly assign to either division comprise: *Trimerorhachis insignis*, *Zatrachys apicalis*, *Eryops erythroliticus*, *E. ferricolus*, *E. reticulatus*, *Diadectes sideroplicus*, *D. biculminatus*, *Helodectes pandius*, *Pariotichus ordinatus*, *P. incisivus*

LOCALITIES OF DOUBLE MOUNTAIN DIVISION

Kiowa Peak.—A few years ago I procured a sandstone slab with impressions of tracks of a reptile, which is now in my collection at Dallas, Texas, but no attempt has been made to identify the animal making them. This slab was procured from a gulch a few miles

south of Kiowa Peak in Stonewall County, Texas (*Second Ann. Rept. Tex. Geol. Sur.* No. 15, p. 406). This would be about the base of the Double Mountain Division.

DISTRIBUTION

Of the eight genera of *Stegocephalia* only four, *Trimerorhachis*, *Zatrachys*, *Eryops* and *Cricotus*, have been found in the Wichita. The first three, together with *Diplocaulus*, *Dissorhopus*, *Acheloma*, and *Anisodexis*, are found also in the Clear Fork, *Cricotus* alone being absent from the latter beds. In all cases, however, the species occurring in the two divisions are different.

Of the *Cotylosauria*, *Diadectes*, *Empedias*, *Pariotichus*, and *Pantylus* are common to both divisions, but only a single species, *Diadectes phaseolinus*, occurs in both. In all other cases the genera are represented by distinct species. *Chilonyx* and *Bolosaurus* are confined to the Wichita, while *Bolbodon*, *Isodectes*, *Hypopnous* and *Labidosaurus* appear only in the Clear Fork.

The *Chelydosauria* are found only in the Clear Fork.

The distribution of the *Pelycosauria* is equally distinctive. While three species of *Dimetrodon* and two of *Naosaurus* extend through both divisions, we have as characteristic genera of the Wichita, *Cleopсыdrops*, *Ctenosaurus*, *Theropleura*, *Metamosaurus*, *Paleosaurus* and *Embolophorus* and of the Clear Fork *Edaphosaurus* only.

It is therefore evident that the divisions of Wichita and Clear Fork which were proposed at first on purely stratigraphic grounds are fully warranted and upheld by the fossils found in them. And it will be found when the invertebrate forms collected from these divisions on the Colorado shall have been studied that this separation is equally warranted there.